

WHAT IS CLAIMED IS

1. A heat exchanging tube assembling apparatus for a heat exchanger having an outer casing in which is arranged partition plate means formed with holes through which heat exchanging tubes, each having a U-shape in an outer appearance, are inserted from an open end side of the casing in a full automatic manner, said heat exchanging tube assembling apparatus comprising:

a tube grasping means for grasping a plurality of U-shaped tubes in a lump at a working position;

a tube positioning means for positioning the grasped tubes to positions from which the U-shaped tubes are inserted into the holes formed to the partition plate means;

a tube taking-out means for sequentially taking out one by one the U-shaped tubes grasped by said tube grasping means; and

a tube feed means for feeding the taken-out tubes toward the partition plate means and inserting the tubes into the holes of the partition plate means.

2. A heat exchanging tube assembling apparatus according to claim 1, further comprising a tube accommodating means in which a plurality of U-shaped tubes are accommodated and a tube mounting means on which the

tube accommodating means are mounted and which is disposed to the working position.

3. A heat exchanging tube assembling apparatus according to claim 2, wherein said tube accommodating means is a tube packing case which accommodates the U-shaped tubes lengthily in a lateral direction while keeping U-shaped curved portions of the tubes on bent end sides horizontally and which is opened upward and a plurality of types of the U-shaped tubes including U-shaped curved portions having different radii are disposed from an inside to an outside of the packing case in a plane and the U-shaped tubes whose curved portions have the same radius are piled up, respectively.

4. A heat exchanging tube assembling apparatus according to claim 3, wherein said tube packing case is provided with load shift preventing tube spacers which are long in a lengthwise direction and are intermittently disposed as a fall-down preventing structure in the tube packing case in the lengthwise direction of the tubes to thereby section the respective tubes whose U-shaped curved portions have different radii.

5. A heat exchanging tube assembling apparatus according to claim 1, further comprising a guide means

disposed on a floor on which the heat exchanging tube assembling apparatus is disposed and a pair of L-shaped frame members which is disposed to be movable on the guide means and by which said tube grasping means, said tube taking-out means and said tube feed means are supported through horizontal arms.

6. A heat exchanging tube assembling apparatus according to claim 5, wherein said guide means is a pair of rails mounted on the floor in parallel with each other.

7. A heat exchanging tube assembling apparatus according to claim 5, further comprising a tube taking-out portion support arm disposed to be perpendicular to the horizontal arms on a horizontal plane at extreme ends of the horizontal arms and said tube grasping means and said tube taking-out means are supported to be rotatable by said taking-out portion support arm.

8. A heat exchanging tube assembling apparatus according to claim 7, wherein tube positioning means for setting the tubes at a position where the tubes are inserted by moving the tube horizontally and vertically and turning the U-shaped tubes about a horizontal axis thereof is composed of the pair of L-shaped frame members, the respective horizontal arms supported by the L-shaped frame

members to be movable upward and downward, the taking-out portion support arm and a reversing beam turnably provided to the taking-out portion support arm.

9. A heat exchanging tube assembling apparatus according to claim 7, wherein said tube grasping means and said tube taking-out means constitute a set of a tube taking-out unit in operative combination thereof and a plurality sets of the tube taking-out units are disposed with an interval along a longitudinal direction of the taking-out portion support arm.

10. A heat exchanging tube assembling apparatus according to claim 2, wherein said tube grasping means includes a thin sheet-shaped hanger which is lowered and inserted into the tube accommodating means in an approximately vertical state and moved in a lateral direction so as to abut against one side surface of a group of the U-shaped tubes which are packed in the tube accommodating means in a manner piled up vertically in a row, a hook which projects from a lower end of the thin sheet-shaped hanger in a lateral direction and is inserted below a lowermost tube, and a support arm which is disposed in parallel with said hanger and which abuts against another side surface of the group of the tubes in a vertical state and clamps the group of the tubes between

the tubes and the hanger by locking the lower end thereof to said hook.

11. A heat exchanging tube assembling apparatus according to claim 10, wherein said hook is turned in a direction where extreme ends of said hanger and said support arm are released.

12. A heat exchanging tube assembling apparatus according to claim 10, wherein said tube taking-out means includes a push piece for pushing the plurality of tubes grasped by said hanger of the tube grasping means and said support arm thereof to a side of said hook at the extreme ends of said hanger and said support arm, a push cylinder for driving said push piece, a grooved roller for supporting a single tube positioned on the hook side from the lower side thereof, a link for supporting said grooved roller, and a cylinder unit for moving said link in a vertical and lateral directions to thereby cause said link to take out the tube supported by said grooved roller in a state that said hook is turned to release the extreme ends of the hanger and the support arm.

13. A heat exchanging tube assembling apparatus according to claim 12, wherein said grooved roller for supporting the tube from the lower side thereof and said

link for supporting the grooved roller are supported to be rotatable by a shaft at a tube taking-out position and usually disposed at the tube taking-out position by a spring and when a U-shaped curved portion of the U-shaped tube passes at the tube insertion time, said grooved roller and said link are operated to escape in a tube inserting direction through the shaft.

14. A heat exchanging tube assembling apparatus according to claim 1, wherein said tube feed means includes a base, a roller support frame supported by the base to be movable upward and downward, a guide roller supported by the roller support frame and receiving the extreme end of the tube through a reciprocation of the guide roller along the tube inserting direction, and feeding drive rollers and follower rollers which are disposed downstream of the tube inserting direction of the guide roller of the roller support frame and rotated so as to clamp the tube to thereby feed the tube to the partition plate means of a heat exchanger.

15. A heat exchanging tube assembling apparatus according to claim 14, wherein said tube feed means includes an introduction mechanism having an air chuck for introducing the tube from the tube taking-out means to the positions of said drive rollers and said follower rollers

through the reciprocating movement thereof in the tube inserting direction together with or in place of said guide rollers.

16. A heat exchanging tube assembling apparatus according to claim 15, wherein said tube feed means includes a cylinder unit for pushing the U-shaped bent end side of the tube to the side of the partition plate means.

17. A heat exchanging tube assembling apparatus according to claim 16, wherein said tube feed means includes a force gauge provided to said cylinder unit for pushing the bent end of the U-shaped tube.

18. A heat exchanging tube assembling apparatus according to claim 1, wherein a taper-shaped cap having a sharp extreme end is mounted to an open end side of the U-shaped tube and a guide member is provided to a lower portion of the hole formed to the partition plate means so as to guide the cap into the hole.

19. A heat exchanging tube assembling apparatus according to claim 1, wherein said tube grasping means includes self-determination means for automatically determining a position where a subsequent tube is grasped and taken out the subsequent tube in accordance with a

position at which an initial tube is grasped and taken out at a tube grasping position.

20. A heat exchanging tube assembling apparatus according to claim 1, wherein said tube feed means includes a control means for self-determining a position where the tube is inserted into the hole of the partition plate means in accordance with a work data to thereby automatically determine the position where the respective tubes are inserted.

21. A heat exchanging tube assembling apparatus according to claim 1, wherein said tube grasping means, said tube positioning means, said tube taking-out means and said tube feed means include operation sections, respectively, and at least one of said operation sections is provided with an element for achieving an abnormal load detecting function, an abnormal load automatic avoiding function or an emergency stop function.

22. A heat exchanging tube assembling apparatus according to claim claim 1, wherein said tube feed means includes a speed detection means for detecting an operating speed of a tube to be fed therefrom.

23. A heat exchanging tube assembling method for a

heat exchanger having an outer casing in which is arranged partition plate means formed with holes through which heat exchanging tubes, each having a U-shape in an outer appearance, are inserted from an open end side of the casing in a full automatic manner, said heat exchanging tube assembling method comprising the steps of:

taking out each predetermined number of the U-shaped tubes disposed in an accommodation place;

stocking the taken-out tubes to a stock position sequentially at a predetermined inserting portion from which the tubes are inserted into the holes of the partition plate means; and

sequentially taking out the stocked tubes from the stock position one by one and inserting the tube into the holes of the partition plate means, thus assembling the heat exchanging tubes in a predetermined fashion.

24. A heat exchanging tube assembling method according to claim 23, wherein the U-shaped tubes includes a plurality of groups thereof having curved portions of different radii from each other and wherein the holes of the partition plate means are formed into a plurality of groups divided so as to correspond to the groups of the U-shaped tubes so that the tube groups are inserted into corresponding groups of the holes, said U-shaped tubes having different radii being disposed inside to outside in

a horizontal plane and having the same radius being piled vertically in the the accommodation place and after all the tubes belonging to one group are inserted into the corresponding holes, the setup of a next group U-shaped tubes is achieved.

25. A heat exchanging tube assembling method according to claim 24, wherein when the U-shaped tubes are taken out from the accommodation place, the U-shaped curved portions of the tubes on the bent end side are kept horizontally, the U-shaped curved portions are kept vertical at the position where the tubes are stocked and respective groups of the tubes whose U-shaped curved portions each has a smaller radius are sequentially inserted into the holes of the partition plate means.

26. A heat exchanging tube assembling method according to claim 23, wherein a plurality of heat exchangers are disposed in parallel with each other and the tubes are assembled to the heat exchangers in parallel or sequential manner.

27. A heat exchanging tube assembling method according to claim 23, wherein said U-shaped tubes are disposed in a packing case in which the U-shaped tubes having different radii are disposed and the packing case is

introduced to a working portion and removed therefrom by using a conveyer.

28. A heat exchanging tube feed apparatus for a heat exchanger for taking out one by one a plurality of heat exchanging tubes each having a U-shape in an outer appearance and arranged in parallel with each other and feeding the tubes in one direction, comprising:

- a push means for pushing out the heat exchanging tubes;

- a push-out cylinder for driving the push means for pushing out the heat exchanging tubes;

- a grooved roller supporting one tube positioned to a lower side of the tubes from a lower side thereof;

- a link mechanism supporting the grooved roller;

and

- a cylinder means for driving the link mechanism vertically and horizontally and taking out sidaway the tube supported by the grooved roller.

29. A heat exchanging tube feed apparatus according to claim 28, wherein said grooved roller for supporting the tube from the lower side thereof and said link mechanism for supporting the grooved roller are supported to be rotatable by a shaft at a tube taking-out position and usually disposed at the tube taking-out position by a

spring and when a U-shaped curved portion of the U-shaped tube passes at the tube insertion time, said grooved roller and said link mechanism are operated to escape in a tube inserting direction through the shaft.

30. A heat exchanging tube feed apparatus for a heat exchanger for feeding out the heat exchanging tube, received at a predetermined position, in one direction, comprising:

- a base;

- a roller support frame supported by the base to be movable upward and downward;

- a guide roller supported by the roller support frame and receiving an extreme end of the tube through a reciprocation of the guide roller along the tube inserting direction; and

- drive rollers and follower rollers which are disposed downstream of the tube inserting direction of the guide roller of the roller support frame and rotated so as to clamp the tube to thereby feed the tube to the heat exchanger.

31. A heat exchanging tube feed apparatus according to claim 30, further comprising an introduction mechanism having an air chuck for introducing the tube to positions of the drive rollers and the follower rollers through

reciprocating movement thereof in the tube inserting direction together with or in place of the guide rollers.

32. A heat exchanging tube feed apparatus for a heat exchanger for feeding the heat exchanging tube, received at a predetermined position, in one direction, wherein a speed detection means for detecting an operation speed of the tube to be fed is provided.